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Anoplophora glabripennis
Pest Report to support ranking of EU candidate priority pests

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1. Introduction to the report

This document is one of the 28 Pest Reports produced by the EFSA Working Group on EU Priority Pests under task 3 of the mandate M-2017-0136. It supports the corresponding Pest Datasheet published together on Zenodo[1] and applies the methodology described in the Methodology Report published on the EFSA Journal (EFSA, 2019).
This Pest Report has five sections. In addition to this introduction, a conclusion and references, there are two key sections, sections 2 and 3.

Section 2 first summarises the relevant information on the pest related to its biology and taxonomy. The second part of Section 2 provides a review of the host range and the hosts present in the EU in order to select the hosts that will be evaluated in the expert elicitations on yield and quality losses. The third part of Section 2 identifies the area of potential distribution in the EU based on the pest's current distribution and assessments of the area where hosts are present, the climate is suitable for establishment and transient populations may be present. The fourth part of Section 2 assesses the extent to which the presence of the pest in the EU is likely to result in increased treatments of plant protection products. The fifth part of section 2 reviews additional potential effects due to increases in mycotoxin contamination or the transmission of pathogens.

In Section 3, the expert elicitations that assess potential yield losses, quality losses, the spread rate and the time to detection are described in detail. For each elicitation, the general and specific assumptions are outlined, the parameters to be estimated are selected, the question is defined, the evidence is reviewed and uncertainties are identified. The elicited values for the five quantiles are then given and compared to a fitted distribution both in a table and with graphs to show more clearly, for example, the magnitude and distribution of uncertainty. A short conclusion is then provided.

The report has two appendices. Appendix A contains a host list created by amalgamating the host lists in the EPPO Global Database (EPPO, online) and the CABI Crop Protection Compendium (CABI, 2018). Appendix B provides a summary of the evidence used in the expert elicitations.

It should be noted that this report is based on information available up to the last day of the meeting[2] that the Priority Pests WG dedicated to the assessment of this specific pest. Therefore, more recent information has not been taken into account.

For *Anoplophora glabripennis*, the following documents were used as key references: MacLeod et al. (2002 and 2012), Haack et al. (2010).

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[1] Open-access repository developed under the European OpenAIRE program and operated by CERN, https://about.zenodo.org/

[2] The minutes of the Working Group on EU Priority Pests are available at http://www.efsa.europa.eu/sites/default/files/wgs/plant-health/wg-plh-EU_Priority_pests.pdf

2. The biology, ecology and distribution of the pest

2.1. Summary of the biology and taxonomy

Anoplophora glabripennis (Motschulsky), (Coleoptera: Cerambycidae) is a single taxonomic entity and can feed on at least 47 species. It has been established in the USA since 1996. Depending on the climatic conditions, the development of 1 generation can take 1 to 2 years. It is univoltine in the most favourable conditions. For example, *A. glabripennis* has a 1 year cycle in northern Italy (R. Favaro, pers. obs. in Favaro et al., 2015).

Adults live for a month and stay on the tree where it emerged or fly for a short distance. Adult longevity and fecundity are influenced by the larval host plant with eggs per female ranging from 45.9 for the black willow (*Salix nigra*) to 193.3 for Norway maple (*Acer platanoides*) (Smith et al., 2002) and temperature conditions (Haak et al., 2010). Fecundity is also positively correlated with body size and negatively correlated with age (Hu et al., 2009). It may vary in the range of 30–178 viable eggs per female (Keena, 2002 and 2006).

Eggs are laid under the bark of the trunk. Larvae hatch after two weeks and feed (second and third instar) in the cambial layer in the branches and trunk. Later instars move into the wood creating tunnels. Adults emerge from circular 10 mm holes.

2.2. Host plants

2.2.1. List of hosts

Host range (those tree species on which the pest can complete its development) differs between the native range and the areas of invasion (Haack et al., 2010):

- In its native range: *Acer* (Sapindaceae), *Populus* (Salicaceae), *Salix* (Salicaceae), and *Ulmus* (Ulmaceae).
- In the US: *Acer, Aesculus* (Sapindaceae), *Albizia* (Fabaceae), *Betula* (Betulaceae), *Cercidiphyllum* (Cercidiphyllaceae), *Fraxinus* (Oleaceae), *Platanus* (Platanaceae), *Populus*, *Salix, Sorbus* (Rosaceae), and *Ulmus*, with *Acer* as the most commonly infested genus, followed by *Ulmus* and *Salix*.
- In Canada: *Acer, Betula, Populus*, and *Salix*, with *Acer* as the most commonly infested genus.

Appendix A provides the full list of hosts.

2.2.2. Selection of hosts for the evaluation

Based on observations from the EU outbreaks, *A. glabripennis* is able to complete its life cycle on the following genera: *Acer, Aesculus, Alnus*, *Betula, Carpinus*, *Cercidiphyllum*, *Fagus*, *Fraxinus, Platanus*, *Populus, Prunus*, *Salix, Sorbus* and *Ulmus*, with preference for *Acer*, *Betula*, *Salix*, *Aesculus*, and *Populus* and different levels of susceptibility reported on *Populus* (Haack et al., 2010; Faccoli and Gatto, 2016).

Based on observations from the EU outbreaks, *A. glabripennis* is able to complete the life cycle on the following genera: *Acer, Aesculus, Alnus*, *Betula, Carpinus*, *Cercidiphyllum*, *Fagus*, *Fraxinus, Platanus*, *Populus, Prunus*, *Salix, Sorbus* and *Ulmus*. The preferred hosts are in the genera *Acer*, *Betula*, *Salix*, *Aesculus*, and *Populus* (although different levels of susceptibility are reported in *Populus*) (Haack et al., 2010; Faccoli and Gatto, 2016).

Together with *A. nobilis*, *A. glabripennis* has also been observed laying eggs on peach, plum and apricot trees, but the eggs did not hatch (Shang et al., 2000).

The different host preferences and capacities to tolerate *A. glabripennis* attacks observed in different geographical areas could be due to the fact that:

- There are different growing conditions for each plant species in the different areas
- the same genera are represented by different species in the different areas
- the area of origin of the local ALB population can play a major role in host preference

Greater impacts have been reported in urban and suburban areas than in forests in the newly invaded areas. The EU situation is considered to be more similar to that observed in North America in terms of the higher susceptibility observed in urban areas. This could be due to higher stress imposed on urban trees, a smaller community of natural enemies and a higher presence of limiting biotic factors.

2.2.3. Conclusions on the hosts selected for the evaluation

Taking into account the very large number of host species and the similarity of the damage that can occur, only two groups were identified based on the habitats/production systems in which they occur: forests for hardwood production (e.g. *Fagus*) and trees in urban/suburban areas.

2.3. Area of potential distribution

2.3.1. Area of current distribution

Figure 1 provides an overview of the current area of distribution of the pest. *Anoplophora glabripennis* (ALB, Asian longhorn beetle) is native to China and south-east Asia. EU outbreaks have occurred as follows: in Austria (under eradication), Finland (under eradication), France (under eradication, but restricted distribution in Corsica), Germany (under eradication), Italy (restricted distribution), the Netherlands (eradicated), UK (under eradication). Eyre and Haack (2017) provide a map with the locations of outbreaks in Europe as of February 2016.

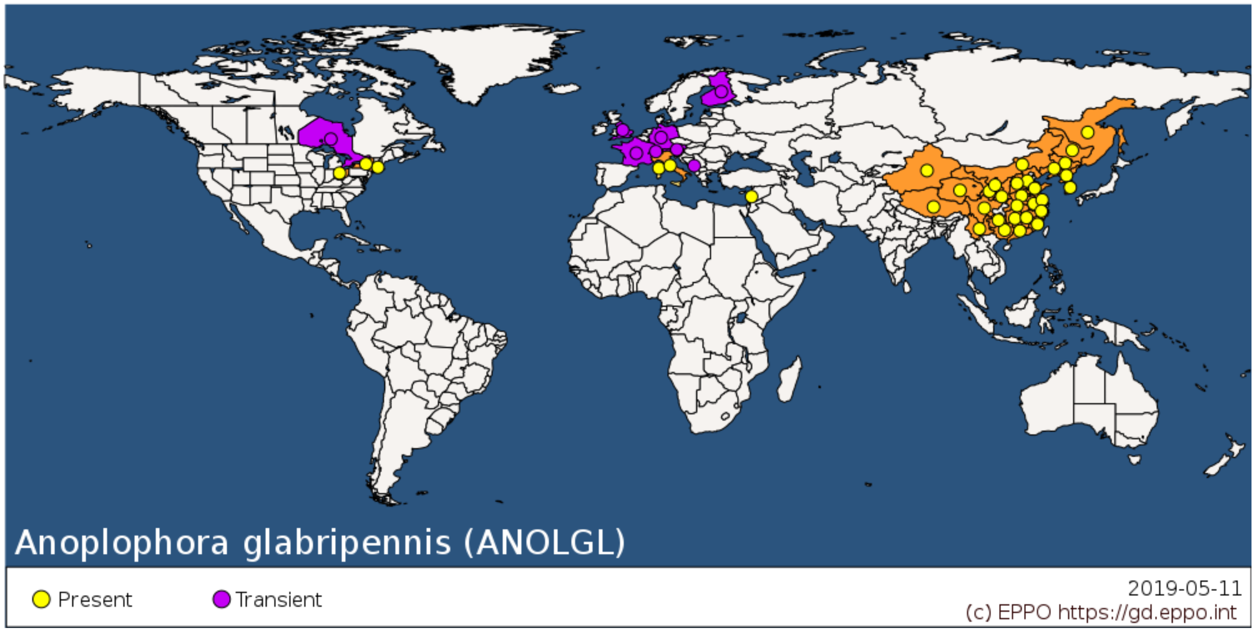

Figure 1 Distribution map of *Anoplophora glabripennis* from the EPPO Global Database accessed 11/05/2019.

2.3.2. Area of potential establishment

The CLIMEX map (Figure 2) based on the parameters selected by MacLeod et al., (2002) shows that, apart from the extreme north of the EU, all areas have a positive ecoclimatic index. Since suitable hosts occur throughout the EU, all the EU can be considered as being within the area of potential distribution for *A. glabripennis* for this report except for the NUTS2 regions in the north of Sweden and Finland.

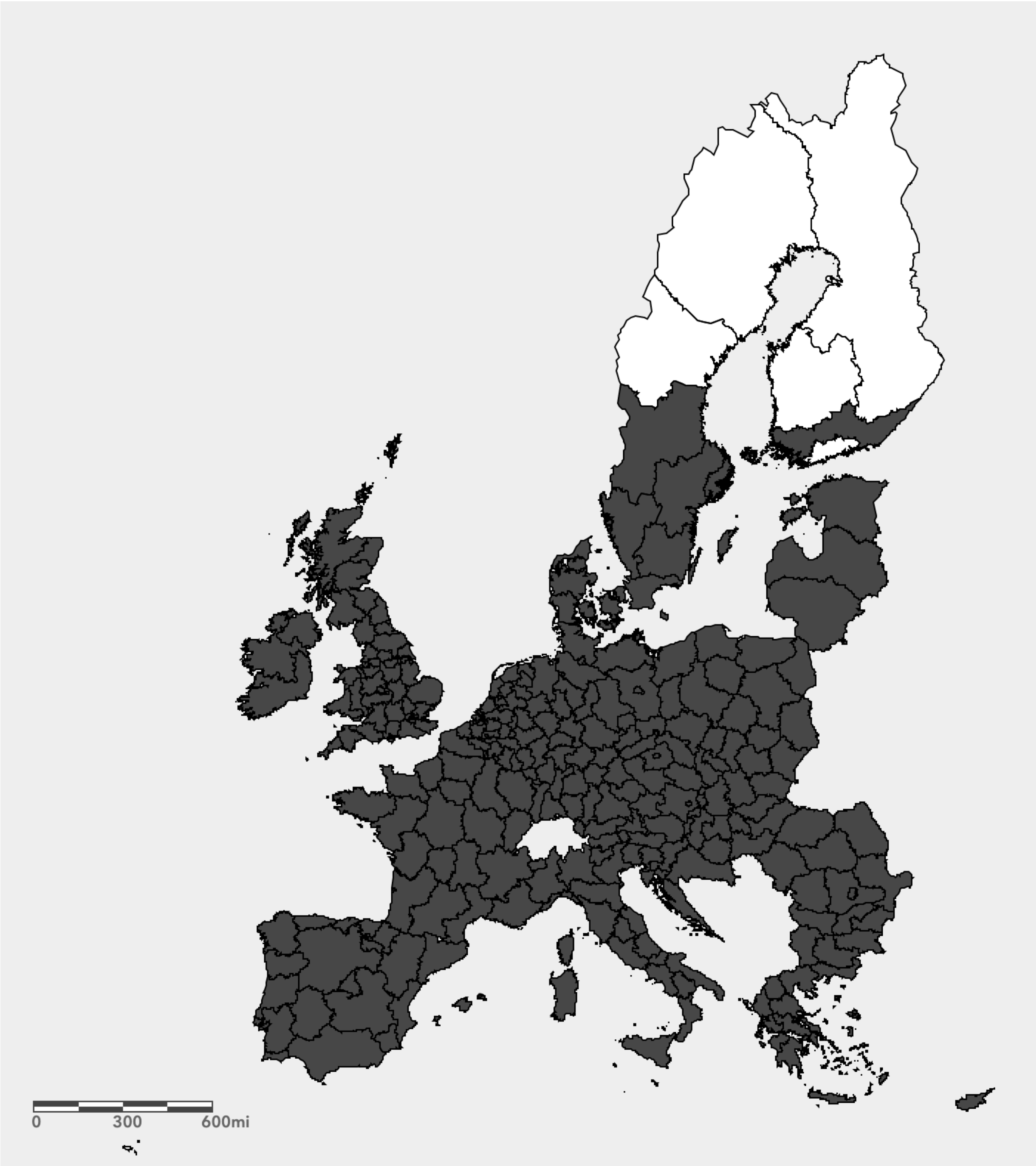

Figure 2 The potential distribution of the pest in the EU NUTS2 regions based on the scenarios established for assessing the impacts of the pest by the EFSA Working Group on EU Priority Pests (EFSA, 2019). This link provides an online interactive version of the map that can be used to explore the data further: https://arcg.is/195j80

2.3.3. Transient populations

Anoplophora glabripennis is not expected to form transient populations in the EU (for "transient" see the definition in EFSA, 2019).

2.3.4. Conclusions on the area of potential distribution

The area of potential distribution for *A. glabripennis* is considered to be the whole of the EU except for the NUTS2 regions in the north of Sweden and Finland because: (i) hosts are widespread throughout the EU, and (ii) all forests and urban areas occur in areas climatically suitable for *A. glabripennis*, except in the north of the EU.

2.4. Expected change in the use of plant protection products

The following examples of control strategies involving PPPs are described in literature:

- soil and tree trunk injection with imidacloprid. It is currently used, e.g. in New York, as precautionary treatment for uninfested trees (MacLeod et al., 2012)
- spraying the pyrethroid cypermethrin in the canopies of host trees to kill adults. This is the most widely adopted method for controlling high populations of *A. glabripennis* in China (Hu et al., 2009)
- bamboo or wooden sticks containing aluminium phosphide inserted into larval frass holes as applied in China (Hu et al., 2009). The phosphine kills *A. glabripennis* larvae
- Injections of methamidophos into the trunks of poplar trees. This is used in China, where it was demonstrated to kill approximately 90% of the first- to fourth-instar larvae and 65% of adults (Hu et al., 2009)

Due to the fact that no effective treatments with plant protection products (PPPs) are currently available (except for high-value trees and because large scale spraying of tree canopies to kill adults is unlikely to be cost-effective), the most suitable PPP indicator is Case "A" and the category is "0" based on Table 2.

Table 1: Expected changes in the use of Plant Protection Products (PPPs) following *Anoplophora glabripennis* establishment in the EU in relation to four cases (A-D) and three level score (0-2) for the expected change in the use of PPPs

Expected change in the use of PPPs	**Case**	**PPPs indicator**
PPPs effective against the pest are not available/feasible in the EU	**A**	**0**
PPPs applied against other pests in the risk assessment area are also effective against the pest, without increasing the amount/number of treatments	B	0
PPPs applied against other pests in the risk assessment area are also effective against the pest but only if the amount/number of treatments is increased	C	1
A significant increase in the use of PPPs is not sufficient to control the pest: only new integrated strategies combining different tactics are likely to be effective	D	2

2.5. Additional potential effects

2.5.1. Mycotoxins

The species is not known to be related to problems caused by mycotoxins.

2.5.2. Capacity to transmit pathogens

The species is not known to vector any plant pathogens.

3. Expert Knowledge Elicitation report

3.1. Yield and quality losses

3.1.1. Structured expert judgement

3.1.1.1. Generic scenario assumptions

All the generic scenario assumptions common to the assessments of all the priority pests are listed in the section 2.4.1.1 of the Methodology Report (EFSA, 2019).

3.1.1.2. Specific scenario assumptions

- Infested plants or parts of plants are removed
- Due to the fact that in woodlands *A. glabripennis*, is a "forest-edge pest", the assessment of the area where impacts could occur is just a proportion of the overall area of potential establishment
- Yield losses include both dead trees and removal of affected parts of a tree
- The removal of infested plants is considered to be a component of uncertainty
- Total yield loss does not correspond to the infestation rate because damaged wood can still be sold at a lower value and damaged plant parts can be removed
- The final product for forests is hardwood (the production of secondary products, e.g. woodchips, is not taken into account)
- Species composition: the population of hardwood forest plants is composed of all potential hosts relevant for wood production in a proportion that reflects the situation at the EU level
- Two possible scenarios are considered for the yield losses
    - The tree does not reach the optimal size for being harvested
    - The tree reaches the optimal size for harvesting, but part of the wood has to be discarded because it is damaged
- Impact in urban areas: parks, private gardens, trees along the streets
- In urban areas affected branches are removed also without pest detection
- In urban areas current practices include the removal of infested plants (because they are dead and/or due to pest detection even when the tree is still alive) and their subsequent replacement
- In suburban areas the detection of a new outbreak could take longer but on the other hand ecosystem services losses are expected to be lower
- Damage in urban areas is assessed by considering that this pest affects small populations of hosts that are not growing in optimal conditions
- For urban areas an average lifespan of a tree of 60-80 years is taken into account

3.1.1.3. Selection of the parameter(s) estimated

In forest plantations the EKE is based on the mortality of trees caused by *A. glabripennis*, since it is assumed that infested trees do not reach the normal size for harvesting. The estimation of mortality is not affected by any replanting. It is assumed that even damage only to the outer layers of the tree will cause total loss of hardwood production. The use of reduced quality trees, e.g. by downgrading its final use from hardwood to pulp wood or firewood, has not been evaluated.

Losses in terms of ecosystem services (regulating, supporting and cultural services) is calculated in terms of the percentage reduction of tree lifespan due to the pest, therefore using, as a variable, the loss in longevity of attacked trees.

3.1.1.4. Defined question(s)

What is the percentage yield loss in hardwood production under the scenario assumptions in the area of the EU under assessment for *Anoplophora glabripennis*, as defined in the Pest Report?

What is the percentage loss in ecosystem services in urban and suburban areas under the scenario assumptions in the area of the EU under assessment for *Anoplophora glabripennis*, as defined in the Pest Report?

3.1.1.5. Evidence selected

The experts reviewed the evidence obtained from the literature (see Table B.1 in Appendix B) selecting the data and references used as the key evidence for the EKE on impact.

A few general points were made:

- Infestation rates can reach up to 60%
- There is no preference in host age (Faccoli, 2018)
- Hull-Sanders et al. (2017): observations on an outbreak in a suburban area of USA

3.1.1.6. Uncertainties identified

- Parts of the infested trees can survive without human intervention
- Average age of trees from very different genera and species
- Distribution of forests close to urban areas
- Heterogeneity of the plots: level of fragmentation and size of forest plots in the EU
- No strong evidence about the higher level of damage at the edges of a plot.
- Effect on lifespan of removing symptomatic/dead parts of trees in urban areas
- Replaced trees could be more or less resistant to the pest
- Is the reduction of ecosystem services (ES) due to the fact that the attacked plant is removed and the new plant substituting it cannot deliver the same amount of ES?
- Level of control of the population caused by the interventions relate to the removal of infested trees

3.1.2. Elicited values for yield losses in forests

What is the percentage yield loss in hardwood production under the scenario assumptions in the area of the EU under assessment for *A. glabripennis*, as defined in the Pest Report?

The five elicited values on yield loss on forest trees on which the group agreed are reported in the table below.

Table 2: The 5 elicited values on yield loss (%) in forests

Percentile	**1%**	**25%**	**50%**	**75%**	**99%**
Expert elicitation	0%	3%	5%	10%	30%

3.1.2.1. Justification for the elicited values for yield loss on forest trees

Reasoning for a scenario which would lead to high yield loss (99th percentile / upper limit)

The upper value takes into account observed invasions of 60% of trees (Dodds et al., 2014) considering the preference for the edges and heterogeneity of plots. Infestation appears at an early stage, causing the tree to die before reaching the harvest time.

Reasoning for a scenario which would lead to low yield loss (1st percentile / lower limit)

The lower value is based on the assumption that the proportion of wood that cannot be used for hardwood production could be so low as not to cause any hardwood loss, due to the position of the exit holes (in the upper part of the plant).

Reasoning for a central scenario equally likely to over- or underestimate the yield loss (50th percentile / median)

The median value reflects the low damage expected on timber production due to the preference for small and stressed plants, the attacked tree can still survive consecutive years of attack and population abundance may be relatively low.

Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile / interquartile range)

The precision is affected by uncertainties on the values lower than the median and the fact that the extreme higher values are unlikely to be observed.

3.1.2.2. Estimation of the uncertainty distribution for yield loss in forests

The comparison between the fitted values of the uncertainty distribution and the values agreed by the group of experts is reported in the table below.

Table 3: Fitted values of the uncertainty distribution on the yield loss (%) in forests

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Expert elicitation	0%					3%		5%		10%					30%
Fitted distribution	0.2%	0.5%	0.8%	1.3%	1.9%	2.7%	3.6%	5.4%	7.9%	9.6%	11.9%	14.7%	18.5%	22.2%	27.0%

Fitted distribution: BetaGeneral (2.1392,1.6113,0.45,1), @RISK7.5

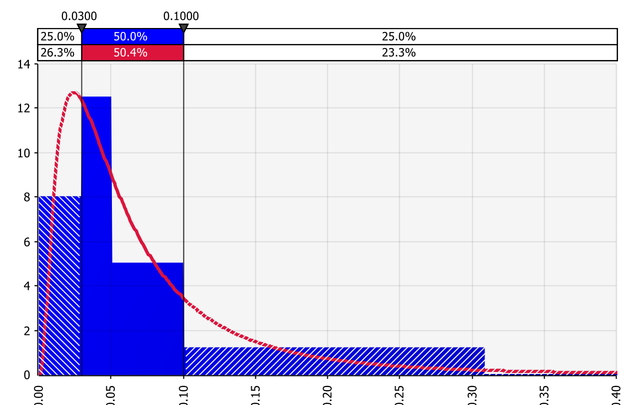

Figure 3 Comparison of judged values (histogram in blue) and fitted distribution (red line) for yield loss in forests.

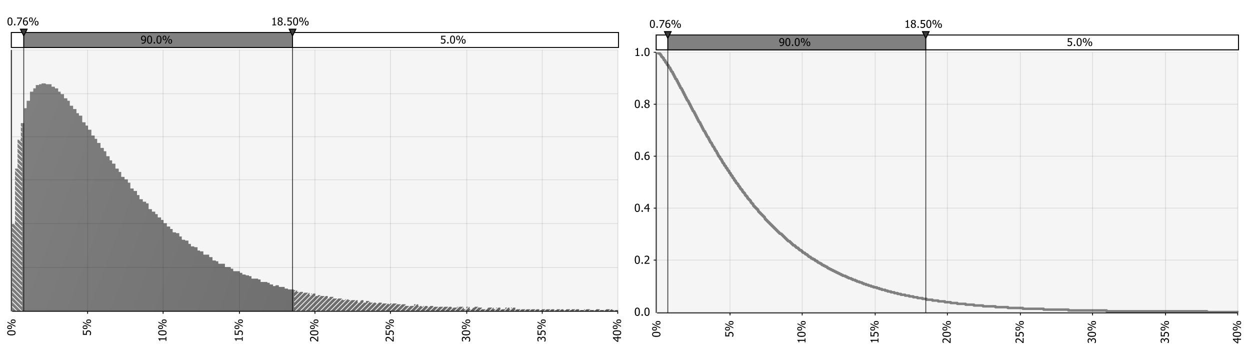

Figure 4 Fitted density function to describe the uncertainties with 90% uncertainty interval (left) and fitted descending distribution function showing the likelihood (y-axis) that a given proportion (x-axis) maybe exceeded (right) for yield loss in forests.

3.1.3. Elicited values for yield losses in urban areas

What is the percentage loss in ecosystem services in urban and suburban areas under the scenario assumptions in the area of the EU under assessment for *A. glabripennis*, as defined in the Pest Report?

The five elicited values on losses in ecosystem services in urban areas on which the group agreed are reported in the table below.

Table 4: The 5 elicited values on losses in ecosystem services (%) in urban areas

Percentile	1%	25%	50%	75%	99%
Expert elicitation	5%	10%	15%	25%	50%

3.1.3.1. Justification for the elicited values for yield loss in urban areas

Reasoning for a scenario which would lead to high yield loss (99th percentile / upper limit)

The upper value takes into account a scenario where:

- The pest is present at a high population density
- The tree species attacked are among the most susceptible
- Survey activity is in place and effective but the detection capacity is low
- The high mortality rate causes a high replacement rate by younger plants, therefore reducing the level of ecosystem services provision

Reasoning for a scenario which would lead to low yield loss (1st percentile / lower limit)

The lower value considers a scenario where:

- The pest is present at a low population density
- The attacked tree species are among the most resistant, or at the end of their life cycle (so the ES losses are limited)
- The survey activity is in place and effective with a high detection capacity
- The attacked trees are replaced with older plants, that are able to provide an ES level almost equal to that of the removed tree
- When attacked trees are removed quickly, this may provide a longer life span for the remaining trees, because they are no longer at risk of attack

Reasoning for a central scenario equally likely to over- or underestimate the yield loss (50th percentile / median)

The damage is expected to be higher in urban areas than in forests, as this pest favours small and stressed plants. Moreover, the pest presence is easier to detect in urban areas and the surveillance activity in urban areas is more effective. The attacked trees can still survive consecutive years of attack, particularly when plants are mature and when high population densities are not present.

Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile / interquartile range)

The precision is affected by uncertainties on the upper side of the curve.

3.1.3.2. Estimation of the uncertainty distribution for yield loss in urban areas?

The comparison between the fitted values of the uncertainty distribution and the values agreed by the group of experts is reported in the table below.

Table 5: Fitted values of the uncertainty distribution on losses in ecosystem services (%) in urban areas

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Expert elicitation	5%					10%		15%		25%					50%
Fitted distribution	4%	5%	5%	7%	8%	10%	12%	16%	21%	24%	29%	34%	40%	45%	52%

Fitted distribution: BetaGeneral (2.1392,1.6113,0.45,1), @RISK7.5

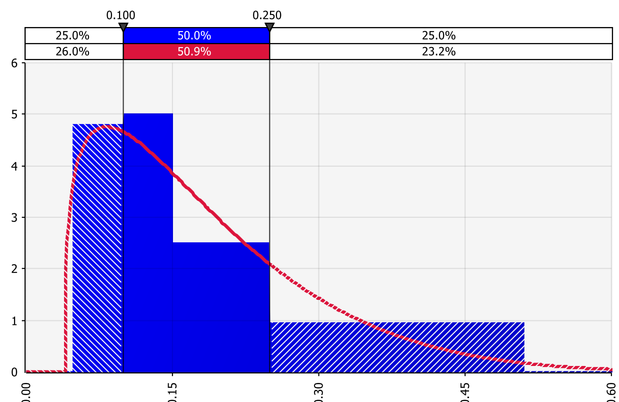

Figure 5 Comparison of judged values (histogram in blue) and fitted distribution (red line) for yield loss in urban areas.

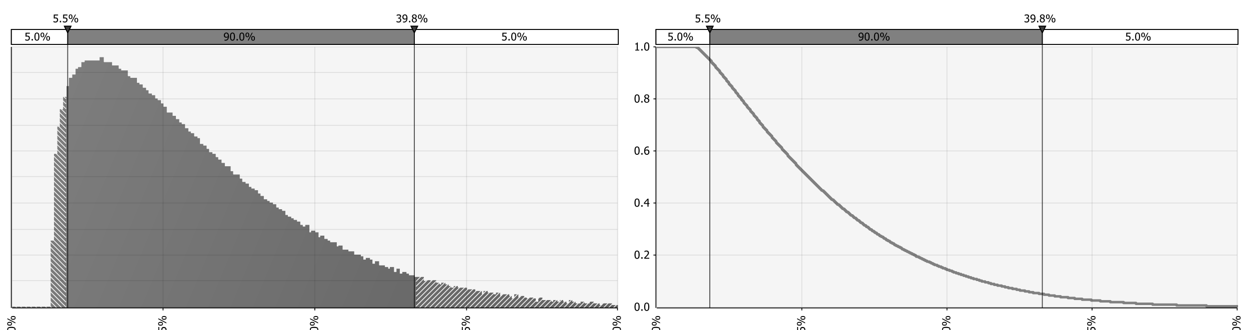

Figure 6 Fitted density function to describe the uncertainties with 90% uncertainty interval (left) and fitted descending distribution function showing the likelihood (y-axis) that a given proportion (x-axis) maybe exceeded (right) for yield loss in urban areas.

3.1.4. Conclusions on yield and quality losses

Based on the general and specific scenarios considered in this assessment, the percentage of yield losses (here based on mortality rate or losses in ecosystem services) is estimated to be approximately:

- 5% (with a 95% uncertainty range of 0.5 – 22.2%) in forests
- 16% (with a 95% uncertainty range of 5 – 45%) in urban areas

3.2. Spread rate

3.2.1. Structured expert judgement

3.2.1.1. Generic scenario assumptions

All the generic scenario assumptions common to the assessments of all the priority pests are listed in the section 2.4.2.1 of the Methodology Report (EFSA, 2019).

3.2.1.2. Specific scenario assumptions

- A population with 2-year cycle is assumed, based on the average EU situation (1-3 year life cycles)
- In the case of forest management, the common practice of gathering the cut logs inside the forest along a forest road is included in the short distance spread and taken into account in the spread rate. Since, in the case of urban infestations, the material resulting from pruning is either shredded on the spot or gathered in a waste facility/storage area which could be far from the infestation location, this component is not included in the assessment of the natural spread rate
- Due to limited knowledge about the host preferences of the pest, the different host species are not considered to influence the spread rate
- Hitchhiking is excluded as it is a major component of ALB human assisted spread in conditions in urban situations
- The spread rate is assessed as a single parameter which takes into account the difference between forest and urban areas conditions

3.2.1.3. Selection of the parameter(s) estimated

The spread rate has been assessed as the number of metres per year.

3.2.1.4. Defined question(s)

What is the spread rate in 1 year for an isolated focus within this scenario based on average European conditions? (units: m/year)

3.2.1.5. Evidence selected

The experts reviewed the evidence obtained from the literature (see Table B.2 in Appendix B) selecting the information and data from the following references as the key evidence for the EKE on spread rate:

- Smith et al., 2004
- Bancroft and Smith, 2005
- Favaro et al., 2015

- Hull-Sanders et al., 2017
- Javal et al., 2017
- Lopez et al., 2017

3.2.1.6. Uncertainties identified

- Influence of the difference in forest structures between urban plantations and natural and managed forests
- Disposal of cut branches: locally stocked only in the forest environment
- Effect of host preference
- Unknown biases in the capture mark release and flight mill experiments

3.2.2. Elicited values for the spread rate

What is the spread rate in 1 year for an isolated focus within this scenario based on average European conditions? (units: m/year)

The five elicited values on the spread rate on which the group agreed are reported in the table below.

Table 6: The 5 elicited values on spread rate (m/y)

Percentile	**1%**	**25%**	**50%**	**75%**	**99%**
Expert elicitation	15	90	160	250	2,000

3.2.2.1. Justification for the elicited values of the spread rate

Reasoning for a scenario which would lead to wide spread (99th percentile / upper limit)

The upper value is based on a scenario of extensive flight activity, using the results from flight mill experiments (Javal et al., 2017; Lopez et al., 2017). In general, these types of trials provide an overestimation, because in real situations the beetle does not fly along a straight line. This scenario also needs to take into account the effect of weather conditions (wind and temperature, as indicated by Wen et al., 1998).

To account for the annual spread rate in a 2-year life cycle, the value was divided by two.

Reasoning for a scenario, which would lead to limited spread (1st percentile / lower limit)

The lower value is based on a scenario that does not support strong spread such as a small pest population (Bancroft and Smith, 2005) in an area of high tree density (e.g. young trees), without suitable weather conditions.

Reasoning for a central scenario, equally likely to over- or underestimate the spread (50th percentile / median)

The median value is based on i) recapturing experiments (Smith et al., 2001, 2004) that are in general underestimations, ii) Chinese observations in poplar groves (Huang, 1991) and iii) Italian observations.

Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile / interquartile range)

The precision is given by the high uncertainty concerning the lower value and low uncertainty for higher values, supported by the observation that the majority of beetles (72%) was recaptured within 300 m of release points according to Smith et al. (2004).

3.2.2.2. Estimation of the uncertainty distribution for the spread rate

The comparison between the fitted values of the uncertainty distribution and the values agreed by the group of experts is reported in the table below.

Table 7: Fitted values of the uncertainty distribution on the spread rate (m/y)

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Expert elicitation	15					90		160		250					2,000
Fitted distribution	18	28	39	55	73	92	112	155	214	259	329	433	614	860	1,331

Fitted distribution: Gamma (0.94924,2093), @RISK7.5

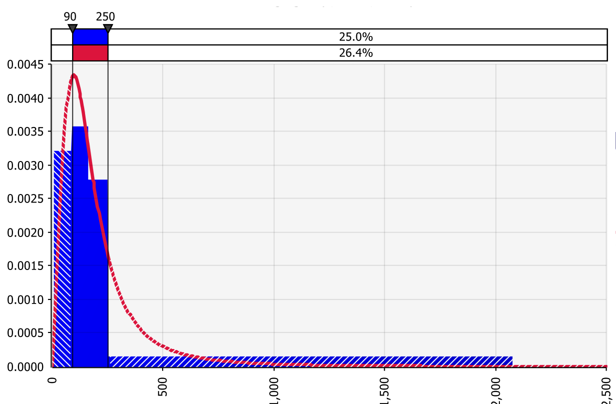

Figure 7 Comparison of judged values (histogram in blue) and fitted distribution (red line) for spread rate.

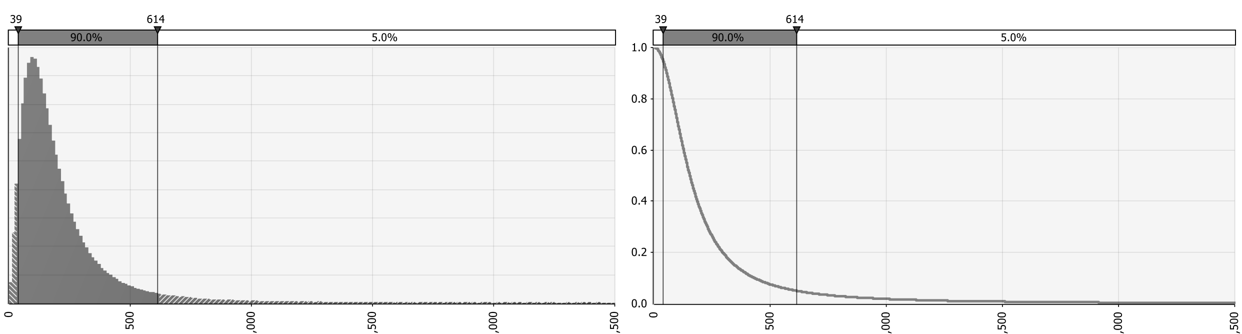

Figure 8 Fitted density function to describe the uncertainties with 90% uncertainty interval (left) and fitted descending distribution function showing the likelihood (y-axis) that a given proportion (x-axis) maybe exceeded (right) for spread rate.

3.2.3. Conclusions on the spread rate

Based on the general and specific scenarios considered in this assessment, the maximum distance expected to be covered in one year by *A. glabripenniss* is approximately 150 m (with a 95% uncertainty range of 28 - 860 m).

3.3. Time to detection

3.3.1. Structured expert judgement

3.3.1.1. Generic scenario assumptions

All the generic scenario assumptions common to the assessments of all the priority pests are listed in the section 2.4.2.1 of the Methodology Report (EFSA, 2019).

3.3.1.2. Specific scenario assumptions

No specific assumptions are introduced for the assessment of the time to detection.

3.3.1.3. Selection of the parameter(s) estimated

The time for detection has been assessed as the number of years between the first event of pest transfer to a suitable host and its detection.

3.3.1.4. Defined question(s)

What is the time between the event of pest transfer to a suitable host and its first detection in forests within this scenario based on average European conditions? (unit: years)

What is the time between the event of pest transfer to a suitable host and its first detection in urban areas within this scenario based on average European conditions? (unit: years)

3.3.1.5. Evidence selected

- Adults and exit holes are very visible and also easy to spot for the general public
- Exit holes at 3-4 m high on the trunk and branches are more difficult to observe than for CLB (Citrus Longhorn Beetle)
- Tree recovery by closing exit holes could mask pest presence and delay symptom expression
- Dodds et al., 2014

3.3.1.6. Uncertainties identified

- Effect of regular pruning activity in managed environments: it could reduce the population size and symptom expression delaying the detection of the pest (not the case of CLB)

3.3.2. Elicited values for the time to detection in forests

What is the time between the event of pest transfer to a suitable host and its first detection in forests within this scenario based on average European conditions? (unit: years)

The five elicited values on time to detection on which the group agreed are reported in the table below.

Table 8: The 5 elicited values on time to detection (years) in forests

Percentile	**1%**	**25%**	**50%**	**75%**	**99%**
Expert elicitation	2	8	10	12.5	15

3.3.2.1. Justification for the elicited values of the time to detection in forests

Reasoning for a scenario which would lead to a long time for detection (99th percentile / upper limit)

The upper value is taking into account the situation in New York and the fact that symptoms were overlooked and adults not identified.

Reasoning for a scenario which would lead to a short time for detection (1st percentile / lower limit)

The lower value is mainly due to prompt identification of adults by phytosanitary services but also the general public as the scenario takes into account the increasing awareness by the public about *Anoplophora* as an invasive species in the EU.

Reasoning for a central scenario, equally likely to over- or underestimate the time for detection (50th percentile / median)

The median value is obtained by comparison with the CLB in urban areas: symptom expression will take many years to be identified.

Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile / interquartile range)

The precision is given by uncertainty concerning higher values and the group is more confident of 10 years rather than 2 years.

3.3.2.2. *Estimation of the uncertainty distribution for the time to detection in forests*

The comparison between the fitted values of the uncertainty distribution and the values agreed by the group of experts is reported in the table below.

Table 9: Fitted values of the uncertainty distribution on the time to detection in forests (years)

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Expert elicitation	2					8		10		12.5					15
Fitted distribution	3.2	4.2	5.0	6.1	7.1	8.0	8.8	10.1	11.4	12.2	13.1	14.0	15.0	15.8	16.8

Fitted distribution: BetaGeneral (1.3141,1.5198,3,19), @RISK7.5

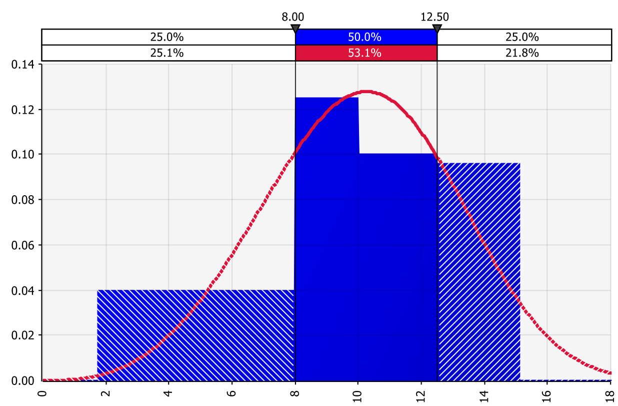

Figure 9 Comparison of judged values (histogram in blue) and fitted distribution (red line) for time to detection in forests.

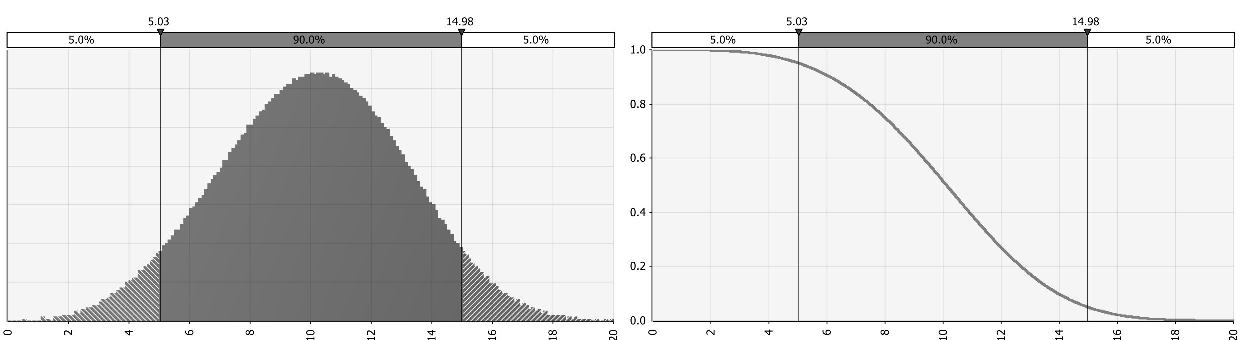

Figure 10 Fitted density function to describe the uncertainties with 90% uncertainty interval (left) and fitted descending distribution function showing the likelihood (y-axis) that a given proportion (x-axis) maybe exceeded (right) for time to detection in forests.

3.3.3. Elicited values for the time to detection in urban areas

What is the time between the event of pest transfer to a suitable host and its first detection in urban areas within this scenario based on average European conditions? (unit: years)

The five elicited values on time to detection on which the group agreed are reported in the table below.

Table 10: The 5 elicited values on time to detection (years) in urban areas

Percentile	**1%**	**25%**	**50%**	**75%**	**99%**
Expert elicitation	2	5	7	8	15

3.3.3.1. Justification for the elicited values of the time to detection

Reasoning for a scenario which would lead to a long time for detection (99th percentile / upper limit)

The upper value takes into account the New York situation and the assumption that symptoms are overlooked and adults not identified.

Reasoning for a scenario which would lead to a short time for detection (1st percentile / lower limit)

The lower value is mainly due to prompt identification of adults by phytosanitary services but also the general public as the scenario takes into account the increasing awareness of the public concerning *Anoplophora* as an invasive species in the EU.

Reasoning for a central scenario, equally likely to over- or underestimate the time for detection (50th percentile / median)

The median value is lower than for forests due to the stronger influence of the general public and higher than for CLB in urban areas due the different location of holes in the trees.

Reasoning for the precision of the judgement describing the remaining uncertainties (1st and 3rd quartile / interquartile range)

The precision is given by the uncertainty concerning differences between ALB and CLB in urban conditions.

3.3.3.2. Estimation of the uncertainty distribution for the time to detection in urban areas

The comparison between the fitted values of the uncertainty distribution and the values agreed by the group of experts is reported in the table below.

Table 11: Fitted values of the uncertainty distribution on the time to detection (years) in urban areas

Percentile	1%	2.5%	5%	10%	17%	25%	33%	50%	67%	75%	83%	90%	95%	97.5%	99%
Expert elicitation	2					5		7		8					15
Fitted distribution	2.8	3.2	3.6	4.1	4.6	5.1	5.6	6.6	7.7	8.5	9.4	10.6	12.1	13.6	15.6

Fitted distribution: BetaGeneral(1.3141,1.5198,3,19), @RISK7.5

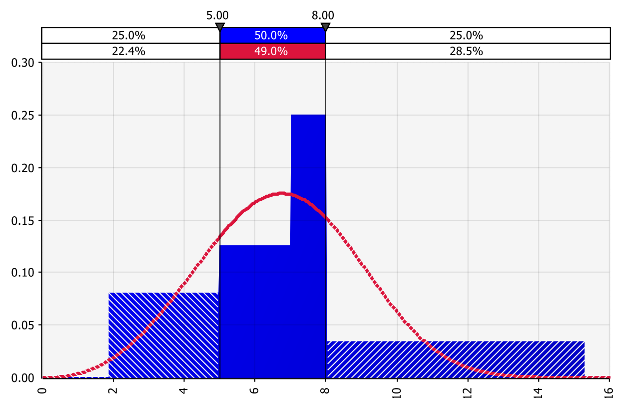

Figure 11 Comparison of judged values (histogram in blue) and fitted distribution (red line) for time to detection in urban areas.

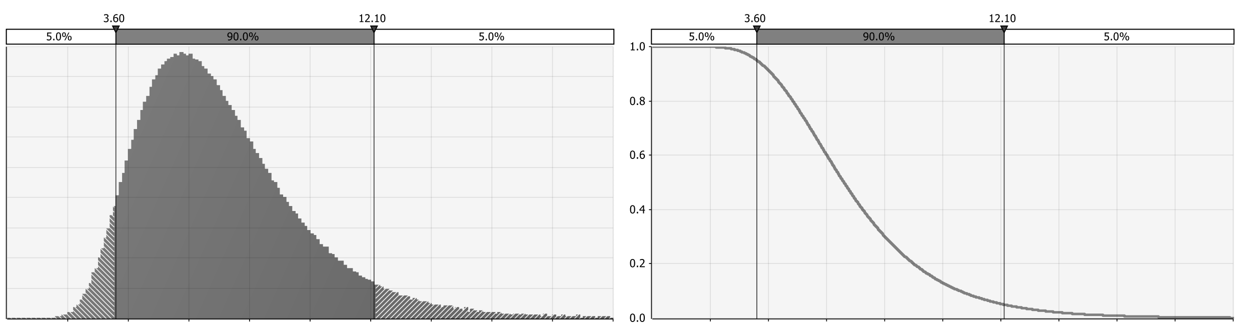

Figure 12 Fitted density function to describe the uncertainties with 90% uncertainty interval (left) and fitted descending distribution function showing the likelihood (y-axis) that a given proportion (x-axis) maybe exceeded (right) for time to detection in urban areas.

3.3.4. Conclusions on the time to detection

Based on the general and specific scenarios considered in this assessment, the time between the event of pest transfer to a suitable host and its detection is estimated to be approximately:

- 10 years (with a 95% uncertainty range of 4.2 – 15.8 years) in forests.
- 7 years (with a 95% uncertainty range of 3.2 – 13.6 years) in urban areas.

4. Conclusions

Hosts selection

Taking into account the very large number of host species and the similarity of the damage that can occur, only two groups were identified based on the habitats/production systems in which they occur: forests for hardwood production (e.g. *Fagus*) and trees in urban/suburban areas.

Area of potential distribution

The area of potential distribution for *Anoplophora glabripennis* is considered to be the whole of the EU except for the NUTS2 regions in the north of Sweden and Finland because: (i) hosts are widespread throughout the EU, and (ii) all forests and urban areas occur in areas climatically suitable for *A. glabripennis*, except in the north of the EU.

Expected change in the use of plant protection products

Due to the fact that no effective treatments with plant protection products (PPPs) are currently available (except for high-value trees and because large scale spraying of tree canopies to kill adults is unlikely to be cost-effective), the most suitable PPP indicator is Case "A" and the category is "0".

Yield and quality losses

Based on the general and specific scenarios considered in this assessment, the percentage of yield losses (here based on mortality rate or losses in ecosystem services) is estimated to be approximately:

- 5% (with a 95% uncertainty range of 0.5 – 22.2%) in forests
- 16% (with a 95% uncertainty range of 5 – 45%) in urban areas

Spread rate

Based on the general and specific scenarios considered in this assessment, the maximum distance expected to be covered in one year by *A. glabripenniss* is approximately 150 m (with a 95% uncertainty range of 28 - 860 m).

Time for detection after entry

Based on the general and specific scenarios considered in this assessment, the time between the event of pest transfer to a suitable host and its detection is estimated to be approximately:

- 10 years (with a 95% uncertainty range of 4.2 – 15.8 years) in forests.
- 7 years (with a 95% uncertainty range of 3.2 – 13.6 years) in urban areas.

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Appendix A – CABI/EPPO host list

The following list, defined in the Methodology Report (EFSA, 2019) as the full list of host plants, is compiled merging the information from the most recent PRAs, the CABI Crop Protection Compendium and the EPPO Global Database. Hosts from the CABI list classified as 'Unknown', as well as hosts from the EPPO list classified as 'Alternate', 'Artificial', or 'Incidental' have been excluded from the list.

Genus	Species epithet
Acer	
Acer	*negundo*
Acer	*pictum*
Acer	*platanoides*
Acer	*pseudoplatanus*
Acer	*rubrum*
Acer	*saccharinum*
Acer	*saccharum*
Acer	*tegmentosum*
Acer	*truncatum*
Aesculus	*hippocastanum*
Albizia	*julibrissin*
Aleurites	*montana*
Alnus	
Betula	
Cajanus	*cajan*
Casuarina	
Citrus	
Corylus	*colurna*
Deciduous	*trees*
Elaeagnus	*angustifolia*
Fagus	
Fagus	*sylvatica*
Fraxinus	
Koelreuteria	*paniculata*
Liriodendron	*tulipifera*
Mallotus	*japonicus*
Malus	
Malus	*domestica*
Melia	*azedarach*
Morus	
Morus	*alba*
Platanus	
Platanus	*orientalis*
Populus	
Populus	*canadensis*
Populus	*dakuanensis*
Populus	*deltoides*
Populus	*maximowiczii*
Populus	*nigra*
Prunus	
Prunus	*serrulata*
Pyrus	

Pyrus	*bretschneideri*
Robinia	*pseudoacacia*
Rosa	
Salix	
Salix	*babylonica*
Salix	*matsudana*
Sophora	
Sorbus	*aucuparia*
Ulmus	
Ulmus	*parvifolia*
Ulmus	*pumila*
Woody	*plants*

Appendix B – Evidence tables

B.1 Summary on the evidence supporting the elicitation of yield and quality losses

Susceptibility	Infection	Symptoms	Impact	Additional information	Reference	Uncertainty
	Incidence	***Severity***	***Losses***			
Multiple species			Cumulative % tree mortality		Nowak et al., 2001 (Tab. 6, p. 121)	Not real values: estimation
Populus			100% Plants 4-10 years old died after 2 to 4 years of consecutive *A. glabripennis* damage *Populus* forests grown in monoculture are killed after 3 to 5 years. Outside of monoculture severe damage to forests may occur within 5 to 8 years	China, Forests	McLeod et al., 2012 from records by Pan, 2005	
Damage to hosts in different habitats				Table 8	McLeod et al., 2012 (Tab. 8, p. 574)	This paper reports observations on very small trees influencing the mortality rate and the average number of larvae/tree
Number and % of infested trees	Number of infested trees/Total infested + high risk trees (%)			Table 5	McLeod et al., 2012 (Tab. 5, p. 558)	
Number of removed trees				Table 1	Smith et al., 2009 (Tab. 1, p. 22)	
Multiple species	Number of infested trees 466 / 12 732			Urban and suburban areas	Favaro et al., 2015	

	• ***Acer* (36%),** • ***Ulmus* (28%),** • ***Betula* (18%),** • ***Salix* (13%)** • *Aesculus* (1%), • *Populus* (0.2%), • *Prunus* (0.9%), and • *Cercidiphyllum* (0.2%)			Tree monitoring conducted during four consecutive years (2009–2012)		
Multiple species	Number of infested trees • *Acer* spp. 124/1694 • *Betula* spp.91/832 • *Ulmus* spp. 73/886 • *Salix* spp. 58/1415 • *Aesculus hyppocastanum* 8/46 • *Populus* spp. 7/531 • *Prunus* spp. 6/3006 • *Carpinus betulus* 0/1085 • *Fagus sylvatica* 0/165 • *Platanus* spp. 0/332			Urban and suburban areas The outbreak was discovered in 2009 but the attack dates 2004 according to dendrochronological data	Faccoli and Gatto, 2016	
Acer spp., *Ulmus* spp., *Betula* spp., *Salix* spp., *Aesculus hippocastanum*, *Prunus* spp., *Populus* spp., *Carpinus betulus*, *Fagus sylvatica*, *Platanus* spp.	1140 infested on surveyed urban trees 29,564 (3.85%)		All the infested trees were cut and destroyed	Veneto Region (Northern Italy), urban and suburban areas: town parks, private gardens and along the main roads. The outbreak was discovered in 2009 but the attack dates 2004 according to dendrochronological data (Faccoli and Gatto, 2016)	Faccoli and Favaro, 2016	

B.2 Summary on the evidence supporting the elicitation of the spread rate

Spread	Additional information	Reference	Uncertainty
Natural spread	Generally within 200 m, but not more than 300 m, as observed during an experiment in a homogeneous young poplar plantation (3 by 5-m tree spacing) in Beijing	Huang, 1991	
Natural spread	A mean dispersal distance of 266 m has been recorded using the mark–release–recapture method	Smith et al., 2001	
Dispersal	Figure 4	Smith et al., 2001	
Natural spread	Median dispersal rate – 30 m per day	Smith et al., 2004	
Natural spread	Further mark–release–recapture studies demonstrated that, although 72% of beetles were recaptured within 300 m of release points, some beetles were recaptured up to 2,600 m away	Smith et al., 2004	
Natural spread	Dispersal potential within the course of a season for males was 2,394m and 2,644m for gravid females. Nevertheless 98% of the marked beetles were recaptured within 920 m from the release point and adults fly to nearby host trees at a rate of 34% per day	Smith et al., 2004	
Natural spread	Median flight distance – 20 m per day. Adults can disperse up to 3 km during their life span but most remain close three where they emerged.	Bancroft and Smith, 2005	
Natural spread	Adults are capable of flying several hundred metres or more in single flight.	McLeod et al., 2012	
Natural spread	Avarage annual population dispersal distance – 106 m, positively correlated with wind velocity and temperature.	McLeod et al., 2012	
Natural spread	Recognizing that a higher beetle density encourages dispersal (Bancroft and Smith, 2005) it is clear that outbreaks will tend to remain localized until some threshold density is reached.	McLeod et al., 2012 Bancroft and Smith, 2005	
Number of exit holes and spread distance	Table 7	McLeod et al., 2012 (Tab. 7, p. 566)	
Pathways	Wood without bark, living woody plants: bonsai. Transport vehicles, wood waste, solid wood packing material with and without bark.	McLeod et al., 2012	
Distance	Figure 2	Favaro et al., 2015	
Distance	Figure 5	Hul-Sanders et al., 2017 (Fig. 5, p. 11)	
Active flight	14 km: max distance recorded with flight mill experiments on adults	Javal et al., 2017	Lab study
Flight distance	Tables 1 and 2 on average flight parameters	Lopez et al., 2017 (Tab. 1, p. 1072; Tab. 2, p. 1073)	

B.3 Summary on the evidence supporting the elicitation of the time to detection

Reference	Results / evidence	Limitation / uncertainties
Detection methods		
Haack et al., 1997	The pest was present in New York City at least 2 years prior to its detection and identification.	
McLeod et al., 2012	Visual inspection is the only method to detect infested trees. Only the adults can be seen outside the trees.	
McLeod et al., 2012	*A. glabripennis* was found in New York in 1996 and is suspected to be arrived in NYC between 1982 and 1985.	
McLeod et al., 2012 (Tab. 7, p. 566)	Authors provide the main distance of newly infested trees from outbreak focus, in relationship with the No of years since the first infestation.	The provided values are estimations
	Assessment of the effectiveness of the Italian eradication programme	
Biology of the pest		
Dodds et al., 2014	Host effect on % of adults' emergence.	
Favaro et al., 2015	In case of univoltine cycles (e.g. Northern Italy) trees with exit holes can be considered infested during the previous year, while in case of oviposition scars on the bark only the tree can be considered infested in the current year.	
Favaro et al., 2015	Spatiotemporal distribution of infested trees.	